

CLAIMS

What is claimed is:

1. A method for deshadowing a laminographic image comprising:
constructing one or more morphological filters using expected sizes of the objects to be imaged; and
applying said filters to a laminographic image including images of said objects.
2. The method of claim 1 further comprising:
differentiating, after said applying, a background of said image from said images of said objects to remove said background.
3. The method of claim 2 further comprising:
thresholding an image resulting from said differentiating to provide a binary image of said objects.
4. The method of claim 3 further comprising extracting said image resulting from said thresholding to disclose pixels representing said objects.
5. The method of claim 1 wherein said morphological filter employs a dilation.
6. The method of claim 5 wherein said dilation uses a power of two structuring element.
7. The method of claim 5 wherein said dilation uses a bi-directional power-of-two structuring element.
8. The method of claim 5 wherein said morphological filter computes morphological operators such that the area of influence of the structuring element expands in a plurality of directions by up to a power of two during said computation.
9. The method of claim 5 wherein said dilation uses a terraced structuring element.
10. The method of claim 5 wherein said dilation uses a sloped structuring element.

11. The method of claim 10 wherein said structuring element is smoothly sloped.
12. The method of claim 1 wherein said morphological filter employs a closing.
13. The method of claim 1 wherein said image is a negative and said morphological filter employs an erosion.
14. The method of claim 1 wherein said image is a negative and said morphological filter employs an opening.
15. The method of claim 1 wherein said morphological filter employs an operation comprising decomposing a structuring element.
16. The method of claim 15 wherein said morphological filter employs an operation comprising at least one piecewise linear dilation by a structuring element of limited support.
17. The method of claim 15 wherein said morphological filter employs an operation comprising at least one piecewise linear erosion by a structuring element of limited support.
18. The method of claim 1 wherein said objects are solder joints.
19. The method of claim 18 wherein said solder joints are on a circuit board.
20. The method of claim 18 wherein a background of said laminographic image are out of focus shadows of said circuit board and components on said circuit board.
21. A method for deshadowing a laminographic image comprising:
selecting a mathematical morphology structuring element larger than examination elements of a laminographic image to be inspected;
performing a mathematical morphological operation on said image; and
differentiating, after performance of said mathematical morphological operation, a background of said image from said examination elements to remove said background.
22. The method of claim 21 wherein said mathematical morphological operation is a dilation.

23. The method of claim 21 wherein said mathematical morphological operation is a closing.
24. The method of claim 21 wherein said image is a negative and said mathematical morphological operation is an erosion.
25. The method of claim 21 wherein said image is a negative and said mathematical morphological operation is an opening.
26. The method of claim 21 wherein said performing a mathematical morphological operation comprises dilation of said image using a power of two structuring element.
27. The method of claim 21 wherein said performing a mathematical morphological operation comprises dilation of said image using a bi-directional power of two structuring element.
28. The method of claim 21 wherein said performing a mathematical morphological operation comprises computing morphological operators such that the area of influence of the structuring element expands in a plurality of directions by up to a power of two during said operation.
29. The method of claim 21 wherein said performing a mathematical morphological operation comprises dilation of said image using a terraced structuring element.
30. The method of claim 21 wherein said performing a mathematical morphological operation comprises dilation by a sloped structuring element.
31. The method of claim 29 wherein said structuring element is smoothly sloped.
32. The method of claim 21 wherein said performing a mathematical morphological operation comprises decomposing a structuring element.
33. The method of claim 31 wherein said performing a mathematical morphological operation comprises at least one piecewise linear dilation by a structuring element of limited support.

34. The method of claim 31 wherein said performing a mathematical morphological operation comprises at least one piecewise linear erosion by a structuring element of limited support.

35. The method of claim 21 wherein said performing a mathematical morphological operation comprises computation of morphological operators such that the area of influence of the structuring element expands in each direction by up to a power of two during said computation.

36. The method of claim 21 further comprising:
thresholding an image resulting from said differentiating to provide a binary image of said examination elements.

37. The method of claim 36 further comprising extracting said image resulting from said thresholding to disclose pixels representing said examination elements.

38. The method of claim 21 wherein said examination elements are solder joints.

39. The method of claim 38 wherein said solder joints are on a circuit board.

40. The method of claim 39 wherein said background comprises out of focus shadows of said circuit board and components on said circuit board.

41. A method for deshadowing a laminographic image comprising:
selecting an ultimate mathematical morphology structuring element radius larger than examination elements of a laminographic image to be inspected;
setting an initial slope for said structuring element;
setting an initial radius of said structuring element to one;
performing a mathematical morphological operation on said image by said set slope to said set radius to achieve a resulting image;
setting a new slope for said structuring element;
increasing the radius of said structuring element;
performing a mathematical morphological operation on said resulting image by the new slope to the increased radius to achieve a new resulting image; and
repeating said setting a new slope, increasing radius, and performing a mathematical morphological operation, on said new resulting image, if the increased radius does not equal said ultimate mathematical morphology structuring element radius.

42. The method of claim 41 wherein said mathematical morphological operation is a dilation.

43. The method of claim 41 wherein said mathematical morphological operation is an erosion.

44. The method of claim 43 wherein said image is a negative.